U.S. DEPARTMENT OF COMMERCE
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PB-258 288

Sherman Reservoir, Sherman County, Nebraska

Corvallis Environmental Research Lab, Oreg

Prepared for

Nebraska State Dept of Environmental Control, Lincoln

Aug 76

288071

PB 258 288

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

SHERMAN RESERVOIR

SHERMAN COUNTY

NEBRASKA

EPA REGION VII

WORKING PAPER No. 561

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
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U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

☆G.P.O. 699-440

TECHNICAL REPORT DATA
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1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Report on Sherman Reservoir, Sherman County, Nebraska		5. REPORT DATE Prepared August 1976
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 561
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final - 1974
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS (This Report)	21. NO. OF PAGES 27
	20. SECURITY CLASS (This page)	22. PRICE $4.00

EPA Form 2220-1 (9-73)

REPORT

ON

SHERMAN RESERVOIR

SHERMAN COUNTY

NEBRASKA

EPA REGION VII

WORKING PAPER No. 561

WITH THE COOPERATION OF THE

NEBRASKA DEPARTMENT OF ENVIRONMENTAL CONTROL

AND THE

NEBRASKA NATIONAL GUARD

AUGUST, 1976

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Nebraska Department of Environmental Control for professional involvement, to the Nebraska National Guard for conducting the tributary sampling phase of the Survey, and to those wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

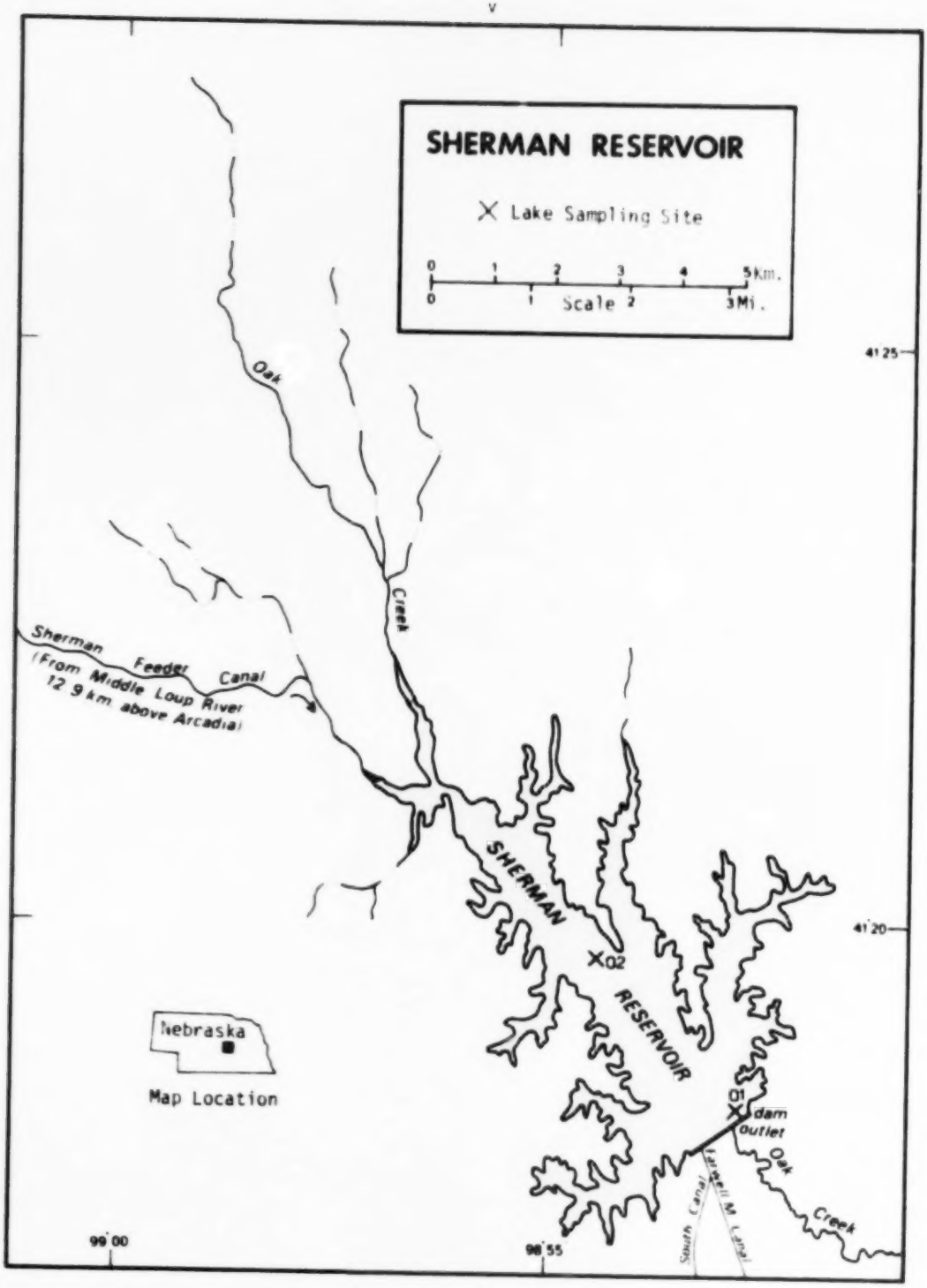
The staff of the Water Pollution Control Division, Department of Environmental Control, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Francis L. Winner, the Adjutant General of Nebraska, and Project Officer Colonel Burl M. Johnson, who directed the volunteer efforts of the Nebraska National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STATE OF NEBRASKA

RESERVOIR NAME	COUNTY
Branched Oak	Lancaster
Harlan County	Harlan
Harry D. Strunk	Frontier
Hugh Butler	Frontier, Red Willow
Johnson	Dawson, Gosper
McConaughy	Keith
Pawnee	Lancaster
Sherman	Sherman
Swanson	Hitchcock


SHERMAN RESERVOIR
Lake Sampling Site
0 1 2 3 4 5km.
0 1 Scale 2 3Mi.
Oak
Creek
Sherman Feeder Canal
(From Middle Loup River
12.9 km above Arcadia)
SHERMAN
RESERVOIR
02
01
dam
Outlet
Oak
Creek
South Canal
Larsen M. Canal
Nebraska
Map Location
41°25
41°20
99°00
98°55

SHERMAN RESERVOIR

STORET NO. 3108

I. INTRODUCTION

Sherman Reservoir was included in the National Eutrophication Survey as a water body of interest to the Nebraska Department of Environmental Control. This report relates only to reservoir sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Sherman Reservoir is eutrophic. It ranked fourth in overall trophic quality when the nine Nebraska reservoirs sampled in 1974 were compared using a combination of six parameters*. Five of the reservoirs had less median total phosphorus, seven had less median dissolved phosphorus, one had less and two had the same median inorganic nitrogen, none had less mean chlorophyll a, and one had greater mean Secchi disc transparency. Depression of dissolved oxygen with depth occurred at sampling station 1 in July.

Survey limnologists did not observe macrophytes or surface concentrations of algae during sampling visits.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Sherman Reservoir was limited by nitrogen at the time the assay sample was collected (04/17/74). The reservoir data indicate nitrogen limitation in September as well.

---

* See Appendix A.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS[+]

A. Lake Morphometry[++]:

1. Surface area: 11.51 kilometers^2.
2. Mean depth: 7.3 meters.
3. Maximum depth: 28.7 meters.
4. Volume: 84.023×10^6 m^3.

B. Precipitation*:

1. Year of sampling: 56.3 centimeters.
2. Mean annual: 58.9 centimeters.

+ Table of metric equivalents--Appendix B.
++ Martin and Hanson, 1966; maximum depth from Hartung, 1974.
* See Working Paper No. 175, "...Survey Methods, 1973-1976".

IV. LAKE WATER QUALITY SUMMARY

Sherman Reservoir was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 17.1 meters at station 1 and 7.6 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table (the July nutrient samples were not properly preserved and were not analyzed).

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SHERMAN COUNTY RESERVOIR
STORET CODE 3108

PARAMETER	1ST SAMPLING (4/17/74) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/ 1/74) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/27/74) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	7.4 - 7.7	7.6	7.7	18.0 - 23.3	22.1	22.8	16.2 - 16.4	16.3	16.2
DISS OXY (MG/L)	10.2 - 10.6	10.5	10.6	3.2 - 8.0	7.2	7.8	7.8 - 9.2	8.8	9.0
CNDCTVY (MCROMO)	14. - 121.	58.	46.	212. - 228.	224.	227.	168. - 170.	169.	169.
PH (STAND UNITS)	****** -**********			8.2 - 8.6	8.5	8.6	8.1 - 8.8	8.6	8.8
TOT ALK (MG/L)	104. - 107.	105.	105.	****** -**********			103. - 108.	105.	105.
TOT P (MG/L)	0.062 - 0.067	0.065	0.065	****** -**********			0.099 - 0.130	0.111	0.106
ORTHO P (MG/L)	0.046 - 0.054	0.050	0.050	****** -**********			0.026 - 0.066	0.043	0.028
NO2+NO3 (MG/L)	0.030 - 0.120	0.059	0.055	****** -**********			0.020 - 0.070	0.043	0.030
AMMONIA (MG/L)	0.030 - 0.060	0.044	0.045	****** -**********			0.020 - 0.060	0.034	0.030
KJEL N (MG/L)	0.300 - 0.700	0.400	0.350	****** -**********			0.200 - 0.500	0.300	0.300
INORG N (MG/L)	0.060 - 0.180	0.102	0.100	****** -**********			0.050 - 0.090	0.077	0.090
TOTAL N (MG/L)	0.330 - 0.820	0.459	0.405	****** -**********			0.260 - 0.530	0.343	0.330
CHLRPYL A (UG/L)	2.7 - 3.2	2.9	2.9	2.3 - 2.5	2.4	2.4	13.4 - 16.2	14.8	14.8
SECCHI (METERS)	0.6 - 0.7	0.7	0.7	1.8 - 2.1	2.0	2.0	1.1 - 1.1	1.1	1.1

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/17/74	1. *Asterionella sp.*	503
	2. Flagellates	457
	3. *Fragilaria sp.*	183
	4. *Stephanodiscus sp.*	137
	5. *Cymbella sp.*	91
	Other genera	229
	Total	1,600
07/01/74	1. *Merismopedia sp.*	461
	2. Flagellates	423
	3. *Cryptomonas sp.*	269
	4. *Schroederia sp.*	154
	5. *Stephanodiscus sp.*	154
	Other genera	76
	Total	1,537
09/27/74	1. *Stephanodiscus sp.*	2,198
	2. *Fragilaria sp.*	244
	3. Flagellates	153
	4. *Cyclotella sp.*	122
	5. *Melosira sp.*	122
	Other genera	244
	Total	3,083

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll a (μg/l)
04/17/74	1	3.2
	2	2.7
07/01/74	1	2.3
	2	2.5
09/27/74	1	16.2
	2	13.4

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.045	0.029	2.0
0.050 P	0.095	0.029	2.6
0.050 P + 1.0 N	0.095	1.029	28.1
1.0 N	0.045	1.029	19.4

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Sherman Reservoir was high at the time the assay sample was collected (04/17/74). Also, the significant increase in yield with the addition of nitrogen alone indicates that the reservoir was limited by nitrogen at that time. Note that the addition of phosphorus alone resulted in a yield not significantly greater than that of the control.

The reservoir data also indicate nitrogen limitation in September as well (the mean inorganic nitrogen/orthophosphorus ratio was 2/1).

V. LITERATURE REVIEWED

Hartung, Ray, 1974. Personal communication (reservoir morphometry). NE Dept. of Env. Control, Lincoln.

Martin, R. O. R., and Ronald C. Hanson, 1966. Reservoirs in the United States. Water Supply Paper #1838, U.S. Geol. Surv., Wash., DC.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3101	BRANCHED OAK	0.044	0.070	456.444	17.033	9.400	0.013
3102	HARLAN COUNTY RESERVOIR	0.112	0.365	476.111	27.822	12.200	0.061
3103	HARRY D. STRUNK (MEDICIN	0.064	0.460	470.500	14.367	14.200	0.009
3104	HUGH BUTLER (RED WILLOW)	0.061	0.090	468.875	16.612	14.400	0.014
3105	JOHNSON RESERVOIR	0.075	0.340	477.667	26.133	8.600	0.009
3106	LAKE MCCONAUGHY	0.027	0.585	409.555	8.644	11.400	0.004
3107	PAWNEE LAKE	0.060	0.175	453.000	15.367	8.800	0.020
3108	SHERMAN COUNTY RESERVOIR	0.067	0.090	451.167	6.717	11.800	0.050
3110	SWANSON RESERVOIR	0.067	0.090	466.333	14.450	11.000	0.016

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NJ
3101	BRANCHED OAK	88 (7)	100 (8)	63 (5)	25 (2)	75 (6)	63 (5)	414
3102	HARLAN COUNTY RESERVOIR	0 (0)	25 (2)	13 (1)	0 (0)	25 (2)	0 (0)	63
3103	HARRY D. STRUNK (MEDICIN	50 (4)	13 (1)	25 (2)	75 (6)	13 (1)	81 (6)	257
3104	HUGH BUTLER (RED WILLOW)	63 (5)	75 (5)	38 (3)	38 (3)	0 (0)	50 (4)	264
3105	JOHNSON RESERVOIR	13 (1)	38 (3)	0 (0)	13 (1)	100 (8)	81 (6)	245
3106	LAKE MCCONAUGHY	100 (8)	0 (0)	100 (8)	88 (7)	50 (4)	100 (8)	438
3107	PAWNEE LAKE	75 (6)	50 (4)	75 (6)	50 (4)	88 (7)	25 (2)	363
3108	SHERMAN COUNTY RESERVOIR	38 (3)	75 (5)	88 (7)	100 (8)	38 (3)	13 (1)	352
3110	SWANSON RESERVOIR	25 (2)	75 (5)	50 (4)	63 (5)	63 (5)	38 (3)	314

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3106	LAKE MCCONAUGHY	438
2	3101	BRANCHED OAK	414
3	3107	PAWNEE LAKE	363
4	3108	SHERMAN COUNTY RESERVOIR	352
5	3110	SWANSON RESERVOIR	314
6	3104	HUGH BUTLER (RED WILLOW)	264
7	3103	HARRY D. STRUNK (MEDICIN	257
8	3105	JOHNSON RESERVOIR	245
9	3102	HARLAN COUNTY RESERVOIR	63

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107 x 10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/12/23

310801
41 19 30.0 098 54 00.0
SHERMAN COUNTY RESERVOIR
31163 NEBRASKA

11EPALES
3

2111202
0056 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/17	09 35	0000	7.6		28	29		107	0.060	0.700	0.120	0.054
	09 35	0005	7.6	10.6		25		106	0.050	0.400	0.070	0.050
	09 35	0015	7.6	10.6		72		105	0.050	0.400	0.060	0.051
	09 35	0050	7.4	10.2		121		105	0.050	0.500	0.060	0.050
74/07/01	15 25	0000	22.6	8.0	84	226	8.60					
	15 25	0005	22.8	7.8		227	8.60					
	15 25	0020	21.7	7.2		222	8.50					
	15 25	0035	20.8	6.8		219	8.40					
	15 25	0056	18.0	3.2		212	8.20					
74/09/27	14 20	0000	16.2	8.8	42	169	8.85	106	0.040	0.500	0.030	0.028
	14 20	0005	16.2	9.0		169	8.79	108	0.060	0.300	0.030	0.028
	14 20	0015	16.2	9.0		169	8.79	103	0.020	0.300	0.030	0.026
	14 20	0045	16.2	8.6		170	8.82	106	0.040	0.300	0.020K	0.026

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/17	09 35	0000	0.067	1.2	
	09 35	0005	0.065		
	09 35	0015	0.065		
	09 35	0050	0.066		
74/07/01	15 25	0000		2.3	
74/09/27	14 20	0000	0.094	16.2	
	14 20	0005	0.106		
	14 20	0009			1.0
	14 20	0015	0.101		
	14 20	0045	0.104		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/12/23

310802
41 20 45.0 098 55 45.0
SHERMAN COUNTY RESERVOIR
31163 NEBRASKA

11EPALES 2111202
3 0033 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/17	10 00	0000	7.7		25	14		105	0.040	0.300	0.050	0.050
	10 00	0005	7.7	10.6		23		105	0.030	0.300	0.030	0.050
	10 00	0015	7.7	10.6		63		104	0.040	0.300	0.040	0.048
	10 00	0025	7.7	10.6		115		104	0.030	0.300	0.040	0.046
74/07/01	15 10	0000	23.2	7.8	72	227	8.60					
	15 10	0005	23.3	8.0		228	8.60					
	15 10	0015	23.2	7.8		228	8.60					
	15 10	0020	23.2	8.0		228	8.60					
74/09/27	14 50	0000	16.4	7.8	42	168	8.16	104	0.030	0.300	0.060	0.063
	14 50	0005	16.4	9.2		168	8.40	104	0.030	0.200K	0.060	0.065
	14 50	0010	16.4	9.2		168	8.10	105	0.020K	0.200K	0.070	0.066

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/17	10 00	0000	0.063	2.7	
	10 00	0005	0.065		
	10 00	0015	0.062		
	10 00	0025	0.066		
74/07/01	15 10	0000		2.5	
	15 10	0010			1.0
74/09/27	14 50	0000	0.114	13.4	
	14 50	0005	0.120		
	14 50	0010	0.130		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX D

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/01/27

3108A1
41 17 37.0 098 52 06.0
OAK CREEK
31109 7.5 LOUP CITY SE
O/SHERMAN RESERVOIR
BRDG ON SEC RD 1 M DWNSTRM SHERMAN DAM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/08/25	14	55	0.470	0.500	0.075	0.490	0.610
74/09/08	14	35	0.470	0.550	0.060	0.480	0.620
74/10/06	14	55	0.660	0.800	0.050	0.550	0.630
74/11/24	17	25	0.768	0.500	0.064	0.490	0.610
74/12/24	16	30	0.910	1.000	0.165	0.360	0.615
75/01/25	11	00	0.830	2.300	0.256	0.320	1.390
75/02/21	16	00	0.915	1.750	0.114	0.497	1.000
75/03/25	14	00	0.681	1.100	0.055	0.485	0.600
75/04/20	14	20	0.510	1.300	0.050	0.530	0.660
75/05/04	17	15	0.390	0.750	0.158	0.575	0.645

STORET RETRIEVAL DATE 76/01/27

310881
41 21 47.0 098 57 25.0
UNNAMED CREEK
31 7.5 LOUP CITY SE
T/SHERMAN RESERVOIR
BRDG ON SEC RD 6.5 MI N OF LOUP CITY
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/08/25	09 55		0.288	0.300	0.020	0.165	0.220
74/09/08	15 20		0.280	0.500	0.015	0.125	0.145
74/10/06	14 20		0.432	0.450	0.045	0.140	0.175
74/11/17	14 40		0.368	0.400	0.050	0.145	0.150
75/06/01	11 30		0.185	0.850	0.025	0.135	0.150
75/06/15	16 20		0.350	1.150	0.170	0.160	0.250
75/06/29	11 00		0.290	1.050	0.100	0.190	0.300
75/07/13			0.145	1.280	0.035	0.125	0.175
75/08/10	15 45		0.015	1.300	0.020	0.110	0.200